

PREDICTING THE DISTRIBUTION OF ANCIENT TREES IN THE UK

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Major Oak, Nottingham



Old Knobbly, Essex

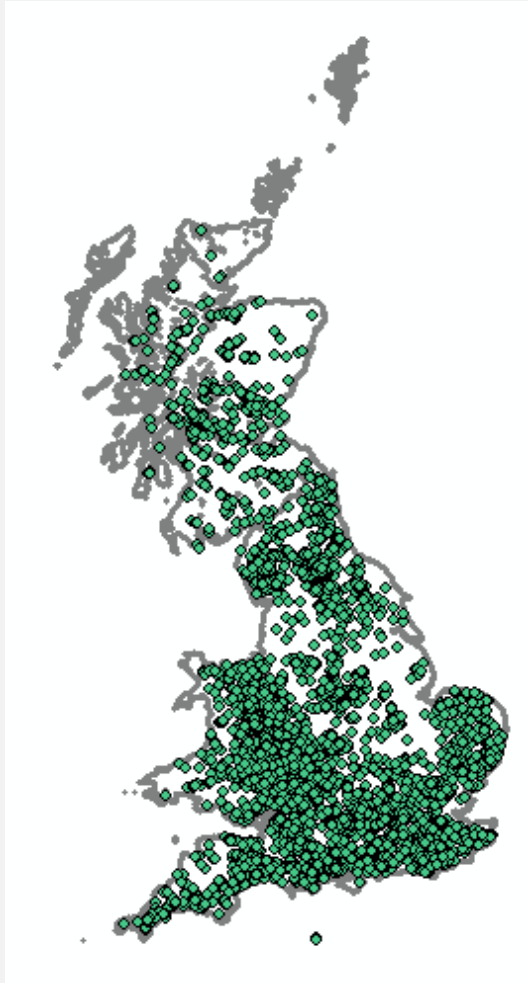


Ankerwycke Yew, Berkshire

THE ANCIENT TREE INVENTORY

- Woodland Trust, Ancient Tree Forum, and TROBI 2004 - 170,000 records in Great Britain

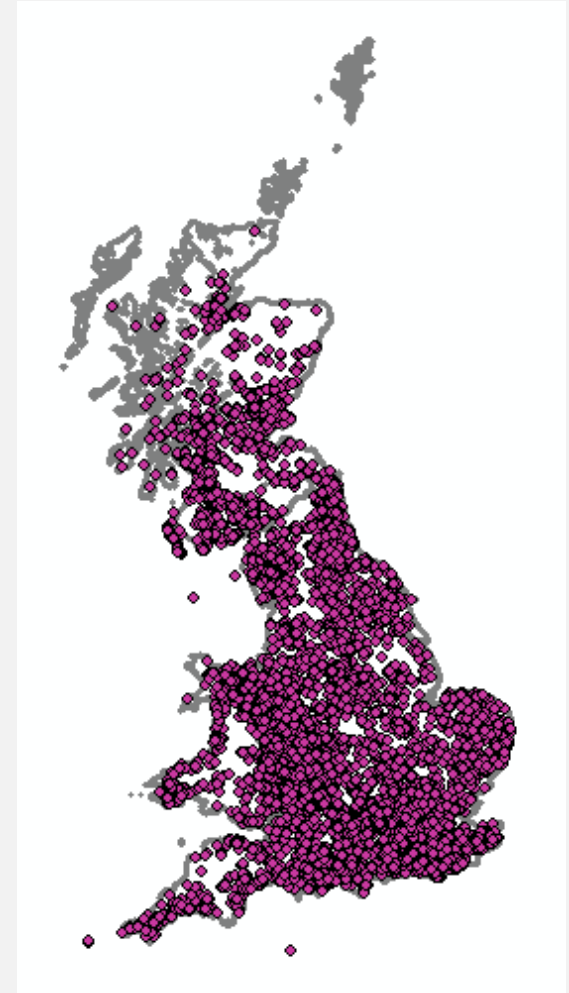
~13,000 ancient trees



~99,000 veteran trees



~43,000 notable trees

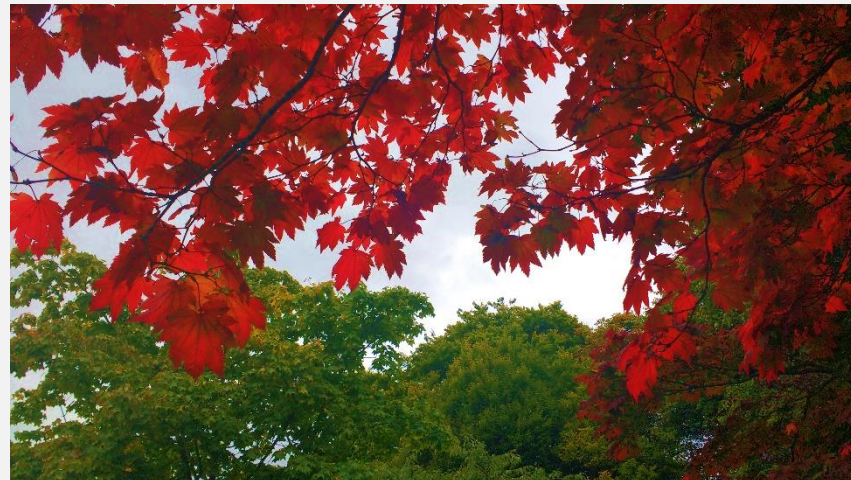


PHD PROJECT AIMS

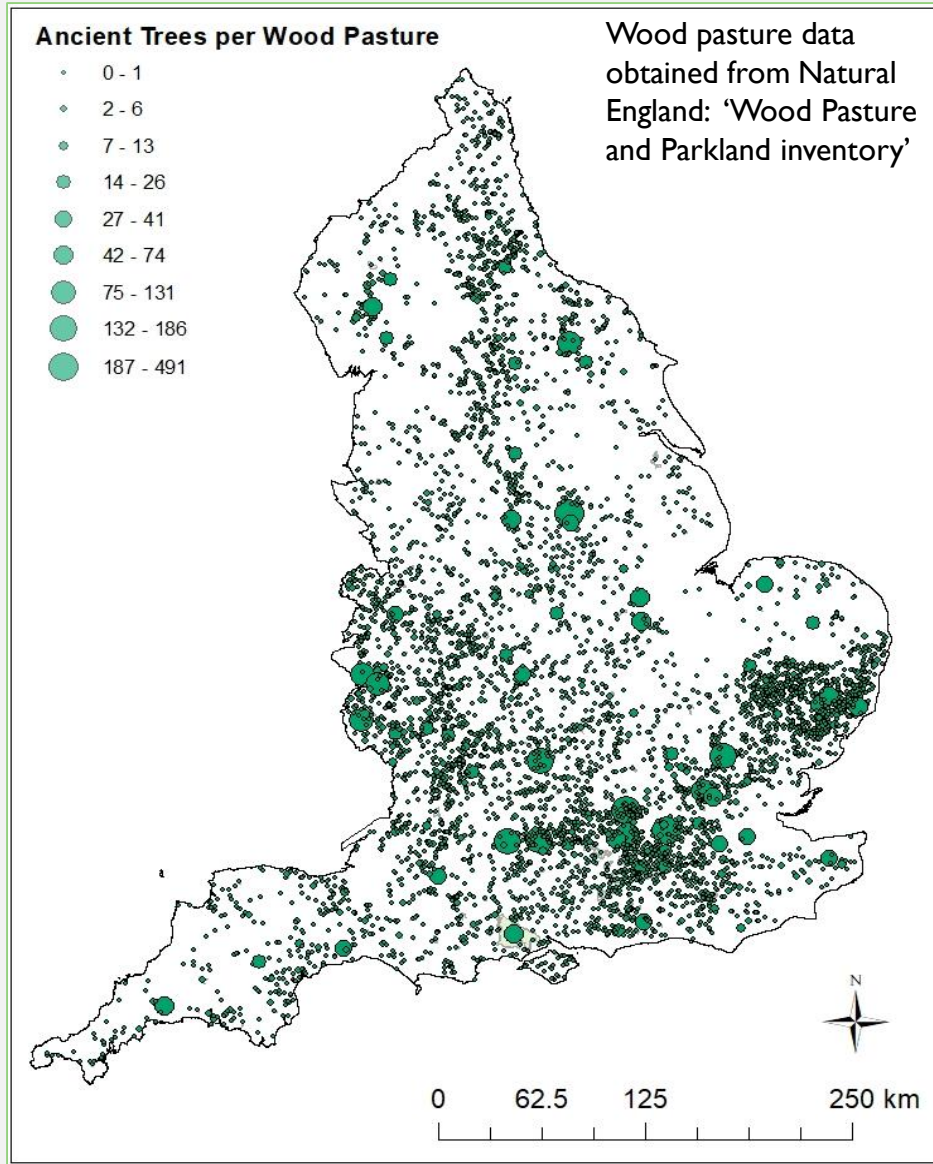
- 1) Predict locations of ancient trees in the UK using ATI records and statistical modelling
- 2) Quantify sampling effort to remove bias in the ATI
- 3) Verify the predictions of new ancient tree locations
- 4) Assess the impacts of ancient tree loss on ecological connectivity and saproxylic species
- 5) Identify new locations to plant trees to become ancient trees in the future

I) PREDICTING NEW LOCATIONS

- Predicting locations of undiscovered ancient trees in the UK in variety of habitats:
 - Wood pastures and parkland
 - Woodland – ancient, coppice etc.
 - Trees outside Woodlands (TOWs): hedges, urban areas, farmland etc.
- Use mathematical modelling, data analysis and statistical techniques such as species distribution modelling (SDM) and other methods to find ancient trees.



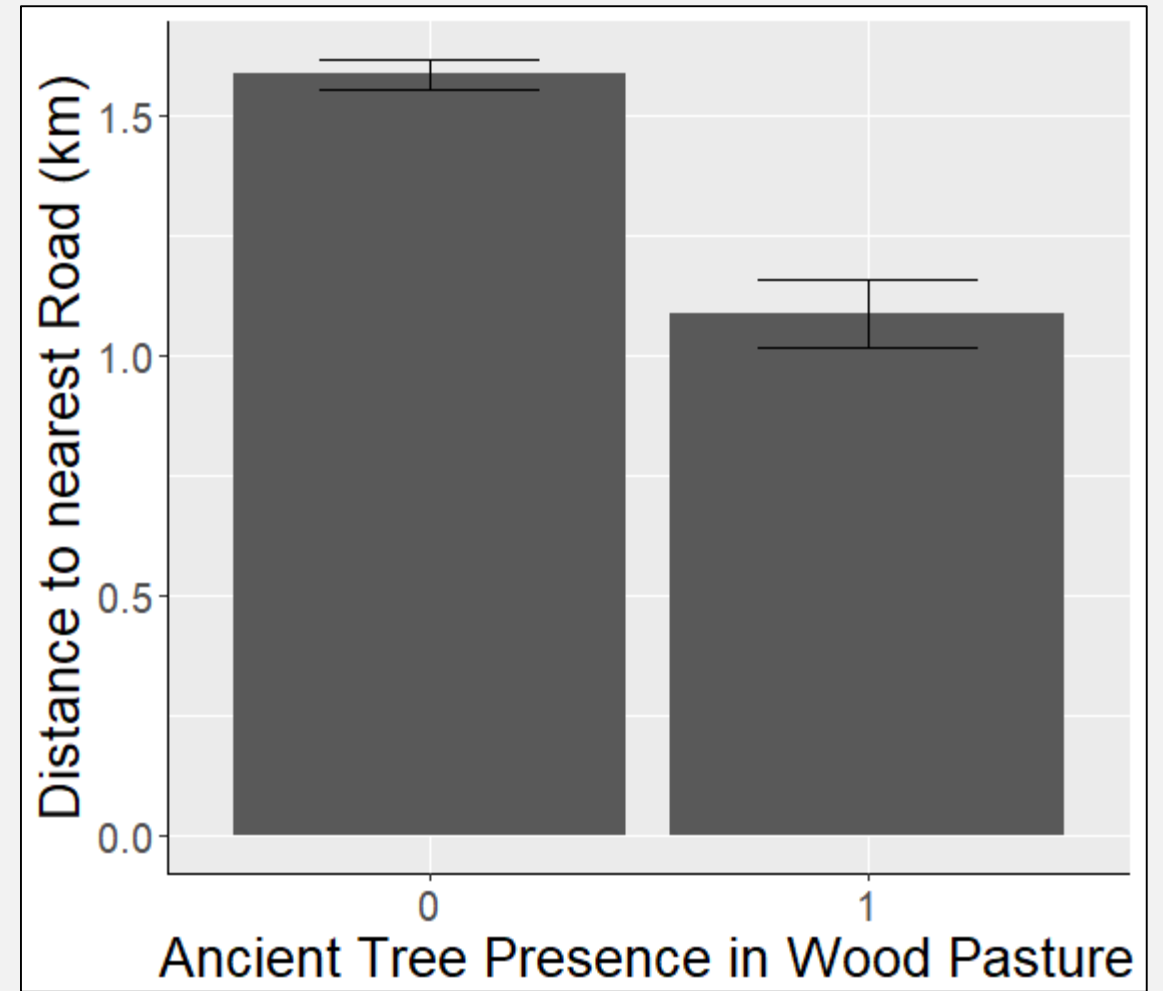
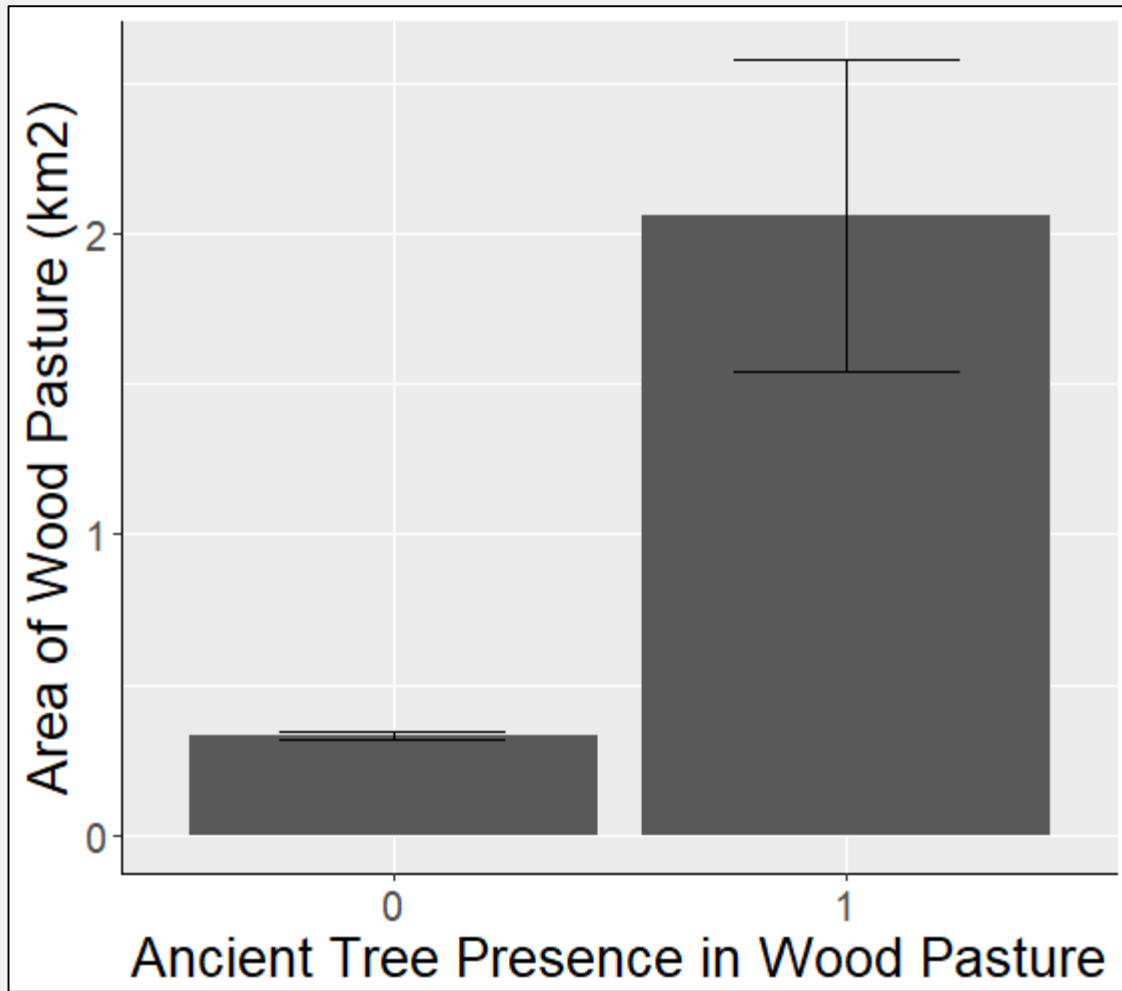
PREDICTING ANCIENT TREES IN WOOD PASTURES



- Ancient trees often found in wood pastures, parklands, royal hunting grounds, and large estates due to land management and continuous estate ownership.
- ~50% of ancient trees in England are located within wood pasture or parkland.
- However, only ~10% of these wood pastures have ATI records.
- Therefore, many more wood pastures could contain ancient trees.

MODELLING ANCIENT TREE ABUNDANCE IN WOOD PASTURES

- Characterise wood pastures using environmental characteristics such as:
 - Elevation
 - Wood pasture area
 - Distance to towns, cities and roads
 - Temperature and precipitation
- Find relationships between these characteristics and the number of ancient trees per wood pasture
- Use these relationships to predict which wood pastures without ATI records might contain ancient trees



Characteristics of wood pastures such as area (left) and distance to nearest major road (right) for wood pastures without ancient trees (0) and with ancient trees (1).

Applications

- ❖ Use model to predict wood pastures with no records that might contain ancient trees
- ❖ Verify predictions and design robust surveys – help from volunteers!
- ❖ Protect wood pasture and parkland habitat from development including:
 - ❖ Ancient and Veteran trees
 - ❖ Rare saproxylic invertebrates, fungi and flora
 - ❖ Grassland flora and fauna e.g. butterflies, bats, birds etc.

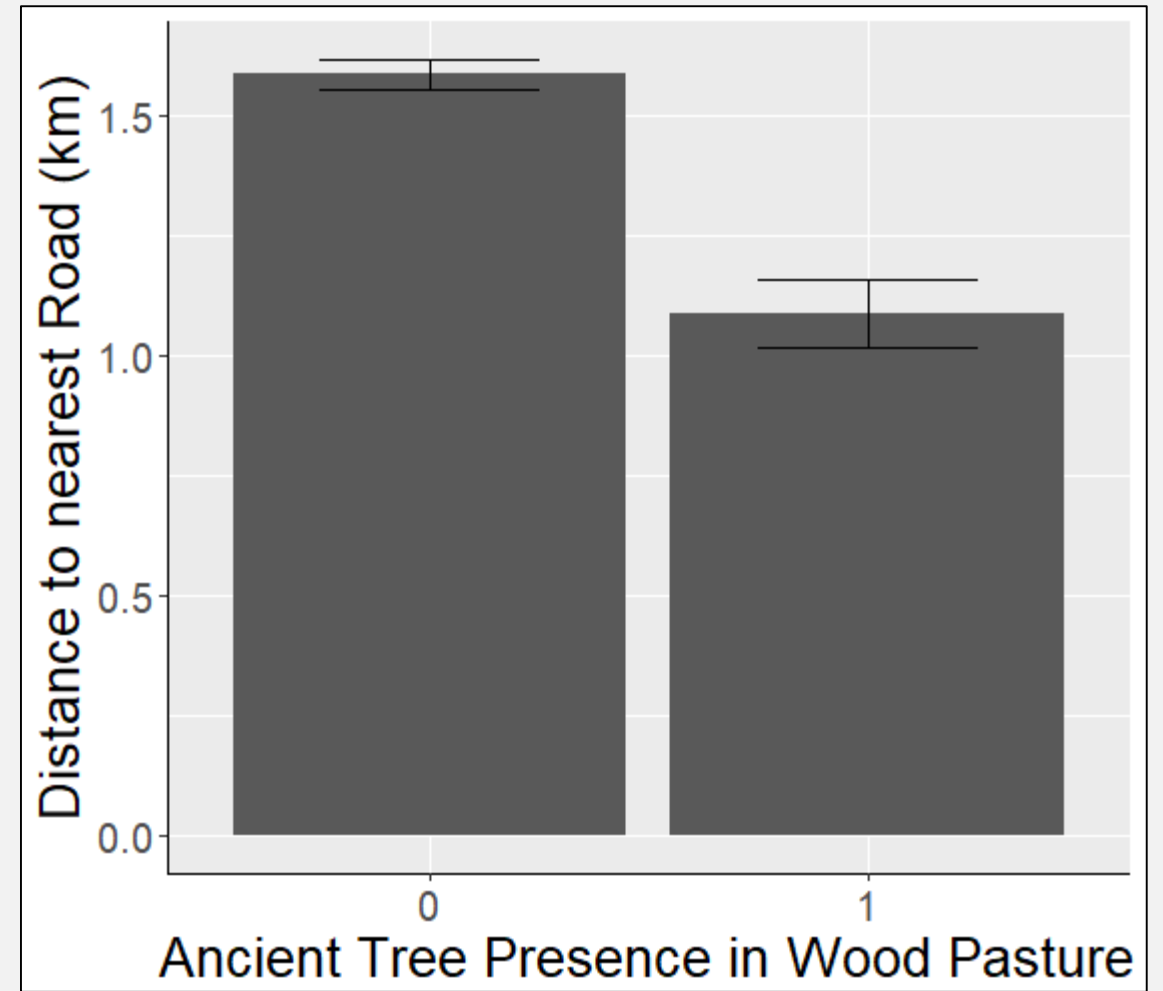
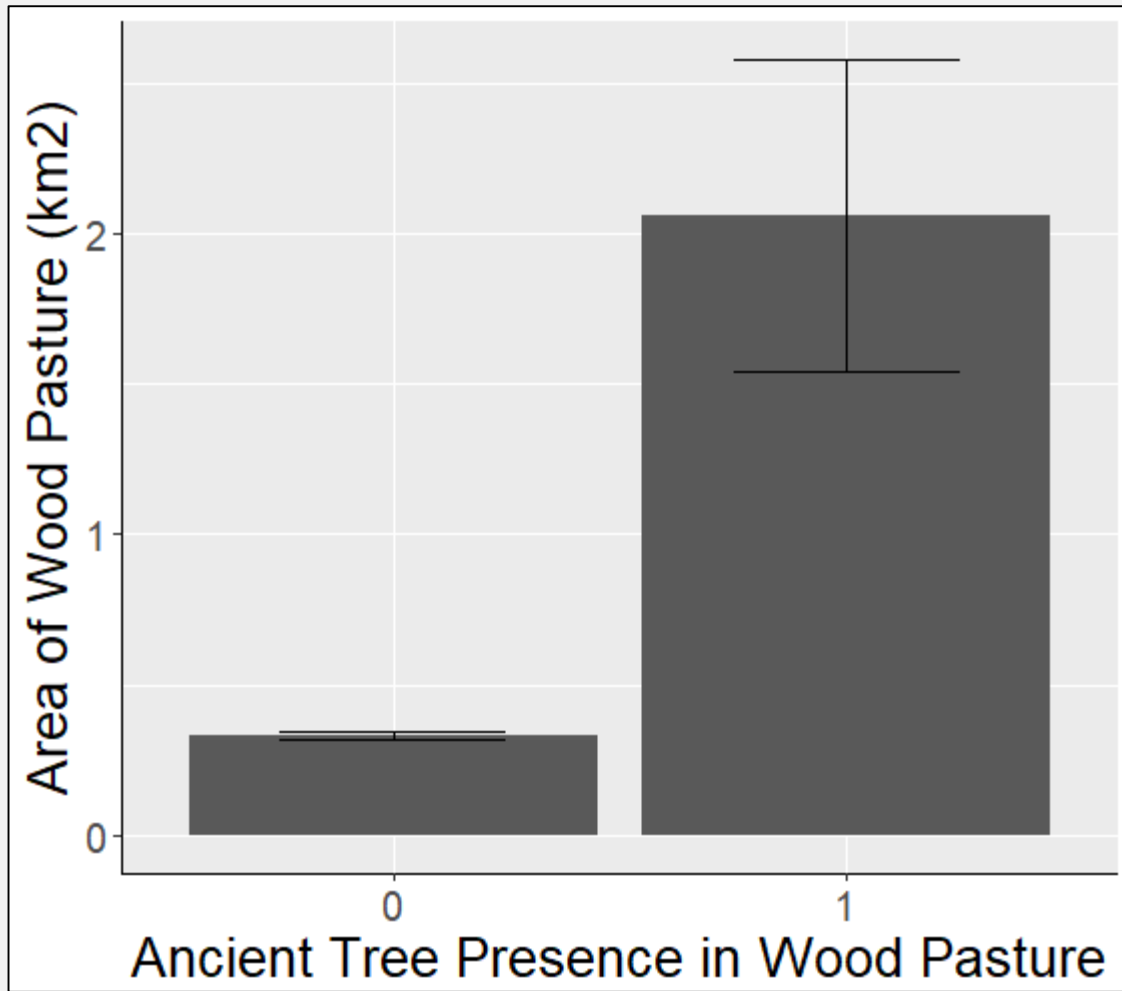
Dead tree at Chirk Castle, Wrexham.
(Photo: woodlandtrust.org.uk)



2) QUANTIFY SAMPLING EFFORT

- The ATI is an amazing example of a Citizen Science recording project and is extremely useful.
- However, recording is not random – volunteers sample for different amounts of time and with different levels of recording skills and are more likely to sample in certain places:
 - Closer to homes, towns, cities
 - Closer to roads and public rights of way
 - At lower elevations
 - Within parks, green spaces and sites of interest
 - Publically accessible sites
- This leads to SAMPLING BIAS...





Characteristics of wood pastures such as area (left) and distance to nearest major road (right) for wood pastures without ancient trees (0) and with ancient trees (1).

Sampling Bias in the ATI

- Are there hotspots of ancient trees or is the distribution due to survey effort and recorder location?
- Project aims to use statistical methods to quantify types of bias in data and to remove them to see actual distribution of ancient trees in the UK.



3) VERIFY PREDICTIONS

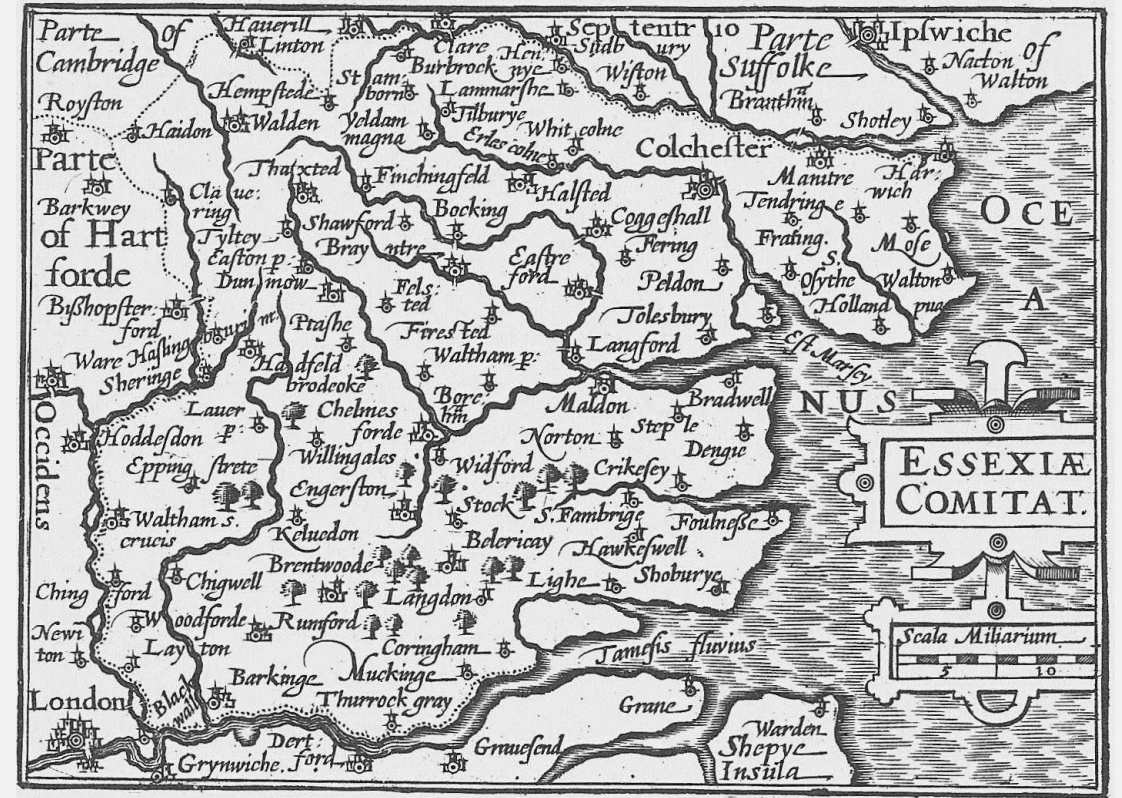
Verifying the new locations and model predictions using:

1) Historical mapping techniques

- Desk survey – easy to carry out
- Compare maps of sites over the years to see continuity of trees

2) The Woodland Trust volunteer survey network

- Directed surveying in areas predicted by model to have high ancient tree abundance
- Robust experimental design
- Random sampling – reduced sampling bias



Map of Essex, by Van Den Keere 1603

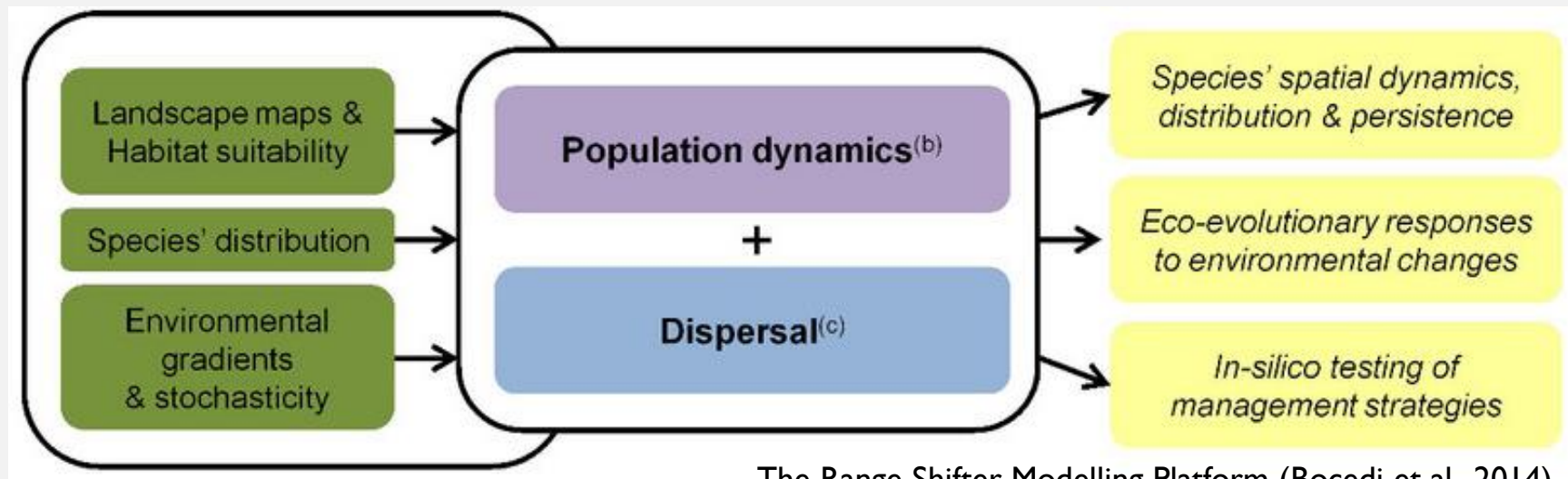
4) IMPACTS OF ANCIENT TREE LOSS

- Specialised habitat for saproxylic species: fungi, lichen, mosses, invertebrates.
- Holes and crevices are habitats for birds, bats, invertebrates and small mammals.
- Also genetic resource of disease resistant/ good growing trees.
- Provide connectivity of dead wood habitat across landscape



SAPROXYLIC SPECIES RANGE SHIFTS

New modelling platform **RangeShifter** (Bocedi et al., 2014) to study species dispersal and spatial dynamics under different environmental scenarios.

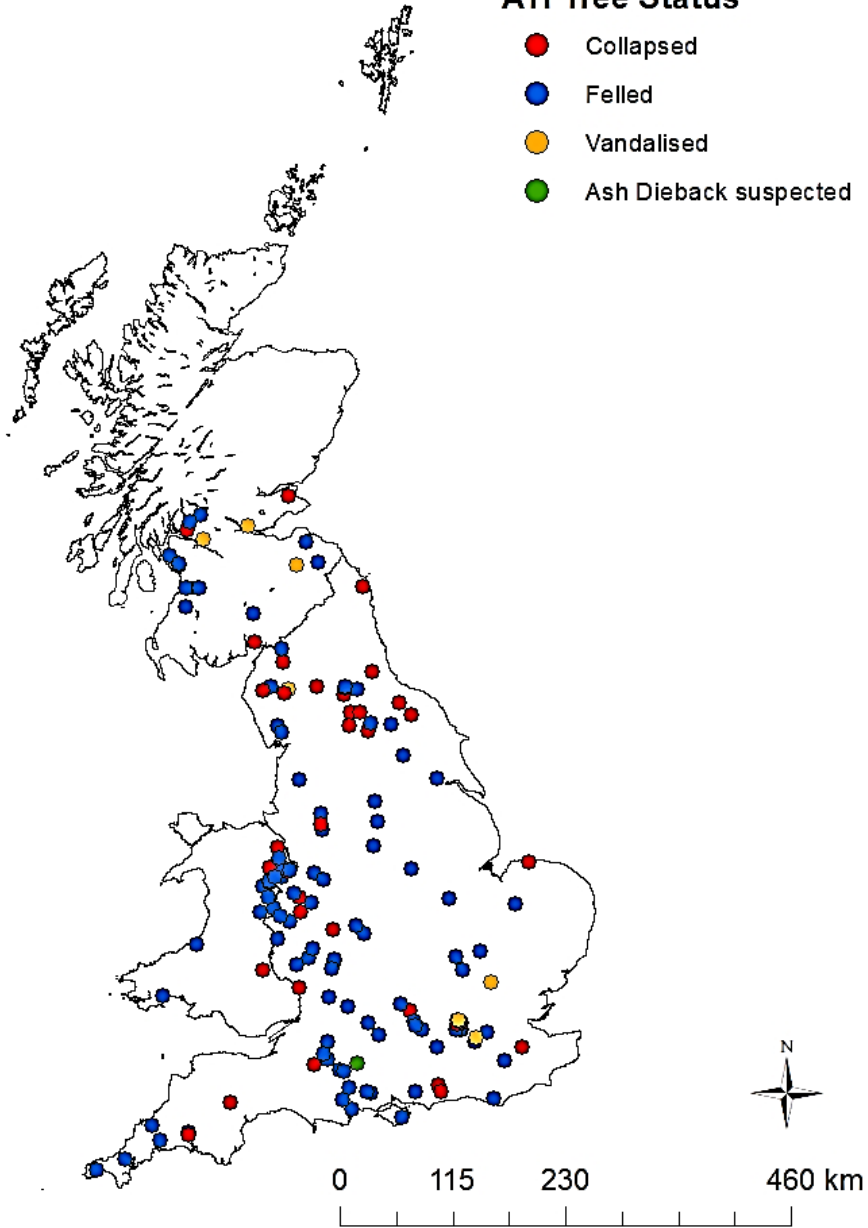


The Range Shifter Modelling Platform (Bocedi et al., 2014)

- Predict the impact of roadside tree loss on the dispersal of woodland species (Henry et al., 2017).
- Modelling range expansions of butterflies in relation to climate change (Heikkinen et al., 2014)
- Evaluate management techniques to aid forest bird survival in a fragmented landscape (Aben et al., 2016)

ATI Tree Status

- Collapsed
- Felled
- Vandalised
- Ash Dieback suspected



Records in the ATI that have been removed or at a high risk of being lost in the near future.

Aim: Use RangeShifter or other spatial dynamic modelling methods to assess how ancient tree loss will affect the dispersal of saproxylic species and to develop effective management techniques to conserve ancient trees.

5) PLANTING NEW TREES

- Combine results from all analyses to identify new areas in the UK to plant trees to become the ancient trees of the future e.g.
 - Areas where tree loss reduces connectivity for saproxylic species
 - Areas least likely to be impacted by climate or environmental change
 - Places where management techniques such as coppicing/ pollarding can be continued



Calke Abbey Estate, Derbyshire

WIDER APPLICATIONS

- Add ancient trees to ATI for their protection/ management
- Help with design/ implementation of conservation projects e.g. HS2
- Influence policy for trees and associated habitats



QUESTIONS?

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NATURAL ENGLAND WOOD PASTURE AND PARKLAND LAYER

- Provisional wood-pasture and parkland inventory created during the Natural England Wood-pasture and Parkland Inventory update.
- From 1976 onwards
- 9815 polygons (combined to 5571)
- Last updated October 2017
- Area with >3 trees (not boundaries) with less than 250m between each
- Mapped to boundary features:
 - 100 m from a park tree or
 - Containing large tree 250 m from a park tree
- Can include woodland if park trees within
- Excluded cemeteries and churchyards unless within park
- Excluded roads and rivers – separate features

VARIABLE	ABBR.	SOURCE
Number of veteran and notable trees per km² of wood pasture	VetNotDensity	ATI database (Woodland Trust 18/04/18)
Area of wood pasture (km²)	Area	Wood Pasture and Parkland BAP Priority Habitat Inventory (Natural England, 4/12/17)
Average elevation across wood pasture (m)	Elevation	OS Terrain 50 DTM (9/01/2018)
Percentage cover of ancient woodland for wood pasture	%AW	Ancient Woodlands (England) inventory - Natural England (08/01/2018)
Percentage cover of NFI for wood pasture	%NFI	National Forest Inventory (NFI) – Gov Database 2016 (04/12/17)
Percentage cover of orchard for wood pasture	%Orchard	Natural England Traditional Orchards HAP England Shapefile (10/01/18)
Distance from wood pasture edge to nearest major road (km)	dist_road	Major Road Network 2016 (GOV) (05/11/2017)
Distance from wood pasture edge to nearest major city centre (km)	dist_city	ONS Major Towns and Cities Dec 2015 (29/11/2017)
Annual average of mean monthly temperature across wood pasture	AvTemp	World Clim – V2 1km Res. Monthly average temperature data (04/04/18)
Annual average of total monthly precipitation across WP	AvPrecip	World Clim – V2 1km Res. Monthly total precipitation data (04/04/18)
Dominant Land Class across Wood Pasture	LandClass	CEH Land Cover 2015 – 1 km dominant target class (14/12/17)
Dominant Agricultural Class across Wood Pasture	AgriClass	Natural England – Agricultural Land Classification (12/04/18)
Dominant Soil Type across Wood Pasture	SoilType	EU Soil Classification – wrbfu (18/04/18)

		glm.pois	glm.nb	hurdle.pois	hurdle.nb	zinfl.pois	zinfl.nb
A) Count – modelling ancient tree abundance (exp of coefficient in bracket)	Intercept	3.749 (42.479)***	-3.856 (0.021)**	3.911 (49.949)***	-16.57 (0.000)	3.904 (49.600)***	-0.256 (0.774)
	Area	2.103 (8.191)***	2.529 (12.541)***	1.403 (4.067)***	1.922 (6.835)***	1.401 (4.059)***	2.111 (8.256)***
	VetNotDensity	0.149 (1.161)***	0.342 (1.408)***	0.101 (1.106)***	0.151 (1.163)***	0.100 (1.105)***	0.109 (1.115)***
	dist_roads	-0.236 (0.790)***	0.003 (1.003)	-0.111 (0.895)***	-0.022 (0.978)	-0.114 (0.892)***	-0.057 (0.945)
	dist_cities	-0.005 (0.995)***	-0.004 (0.996)	-0.006 (0.994)***	-0.012 (0.988)	-0.006 (0.994)***	-0.002 (0.998)
	%ORCHARD	0.032 (1.033)*	0.002 (1.002)	0.061 (1.063)*	0.085 (1.089)	0.058 (1.060)	0.105 (1.111)
	%NFI	0.014 (1.014)***	0.001 (1.001)	0.019 (1.019)***	0.003 (1.003)	0.019 (1.019)***	-0.0005 (1.000)
	%AW	-0.008 (0.992)***	0.027 (1.027)***	-0.008 (0.992)***	0.031 (1.031)*	-0.008 (0.992)***	0.022 (1.022)***
	AvTemp	-0.266 (0.766)***	0.273 (1.314)*	-0.161 (0.851)***	0.508 (1.662)*	-0.166 (0.847)***	-0.064 (0.938)
	AvPrecip	-0.023 (0.977)***	0.001 (1.001)	-0.024 (0.976)***	0.012 (1.012)	-0.023 (0.977)***	0.002 (1.002)
A) Zero – modelling ancient tree presence/ absence (exp of coefficient in bracket)	Intercept			-0.168 (0.845)	-0.168 (0.845)	0.937 (2.552)	0.826 (2.284)
	Area			2.345 (10.44)***	2.345 (10.44)***	-1.977 (0.138)***	-0.792 (0.453)**
	VetNotDensity			0.300 (1.349)***	0.300 (1.349)***	-0.294 (0.745)***	-1.390 (0.249) ***
	dist_roads			-0.004 (0.996)	-0.004 (0.996)	-0.066 (0.517)	-0.138 (0.871)
	dist_cities	n/a	n/a	0.010 (1.010)*	0.010 (1.010)*	-0.012 (0.988)*	-0.009 (0.992)
	%ORCHARD			0.012 (1.012)	0.012 (1.012)	0.018 (1.018)	0.520 (1.682)*
	%NFI			-0.010 (0.990)**	-0.010 (0.990)**	0.014 (1.014)***	0.005 (1.005)
	%AW			0.003 (1.003)	0.003 (1.003)	-0.005 (0.995)	0.006 (1.006)
	AvTemp			-0.168 (0.845)	-0.168 (0.845)	0.131 (1.140)	0.154 (1.167)
	AvPrecip			0.001 (1.001)	0.001 (1.001)	-0.010 (0.990)	-0.003 (0.997)
AIC		14638	3777.4	10321.03	3607.07	10332.55	3508.46
df		10	11	20	21	20	21
LogL		-7309.02	-1877.67	-5140.52	-1783.00	-5146.28	-1733.00

